Evert C. Lawton, Ph.D., P.E.
Consulting Geotechnical Engineer

August 5, 1996

Mr. E. B. King
Jumbo Mining Company
6305 Fern Spring Cove
Austin, Texas 78730

SUBJECT: Preliminary Report on HELP Simulations of Existing Heap Leach Pad at Drum Mine

Dear Mr. King:

I have conducted hydrologic simulations of the existing Drum Mine heap leach pad H-2 using Version 3 of the program Hydrologic Evaluation of Landfill Performance (HELP) model. A profile showing the idealized layering of the materials used in the analyses is given on the attached sheet. Heap leach pad H-2 was selected because it is one of the pads with the thinnest liner size (20 mils) and the smallest ore thickness, which means that the leakage from it would be expected to be high compared to most or all of the other pads. The simulations were conducted over a period of 20 years beginning with the year 1991. 1991 was selected as the starting year because the heaps were taken out of service in October 1, 1990 according to the information provided to me by Dave Hartshorn. The required parameters for the material layers were determined by a combination of field testing, laboratory testing, and estimates based on typical values found in the open literature. Daily values of the primary required weather input data (temperature, precipitation, and solar radiation) were obtained from the Utah Climate Center located at Utah State University for the years 1991 through 1995. The remaining 15 years of data were reproduced from these five years. The 25 year recurrence, 24 hour duration storm event for the site (2.05 in.) was added to the precipitation data on October 15 of the final year of the analysis (2010). Conservative estimates of defects in the PVC liner were used, which therefore likely will result in estimates of high rates of leakage through the liner.

The results are summarized in the attached Tables 1 and 2. The preliminary conclusions determined from these results are as follows:

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1. A small percentage of the total precipitation is predicted to leak through the PVC liner each year. Up through the year 2000, this leakage is absorbed within the rhyodacite above the groundwater table and in the limestone layer.

2. For the years 1991 through 2000, no leakage is predicted to occur through the bottom of the limestone/shale/dolomite layer. In years 2001 through 2010, a small percentage of the precipitation is predicted to leak through the bottom of the limestone/shale/dolomite layer. In this analysis, a total thickness of bedrock of 1000 ft was used. It is my understanding that holes up to 1500 ft have been cored in the rock without finding the groundwater table (other than the perched water table in the rhyodacite stratum). There seem to be some inconsistencies in the results in that the shale and limestone/shale/dolomite layers show no increase in water storage even though they have the capacity to hold more water, yet leakage is predicted to occur through these layers.

3. It is predicted that no leakage will occur into the groundwater table up through the year 2000. After that, a small amount of leakage may occur deep within the bedrock, but its effect on the groundwater is unknown because the location of the groundwater has not been found.

The preliminary results indicate that there is little likelihood that the existing heap leach pads will have an adverse impact on the groundwater beneath the site, at least through the year 2000. I will perform more simulations and carefully check the results before sending you a final report.

Sincerely,

Evert C. Lawton

Evert C. Lawton, Ph.D., P.E.
Utah PE No. 93-190745-2202

Attachments: Tables 1 and 2
Profile of material layering

TABLE 1. Predicted Annual Leakage Rates through the PVC Liner and the Bottom Bedrock Layer.

Year	Total Precipitation (in.)	Leakage through PVC Liner (in.)	Leakage through Limestone/Shale/Dolomite Layer (in.)
1991	7.43	0.179	0.000
1992	5.71	0.128	0.000
1993	8.47	0.183	0.000
1994	9.56	0.104	0.000
1995	7.93	0.077	0.000
1996	7.43	0.088	0.000
1997	5.71	0.130	0.000
1998	8.47	0.183	0.000
1999	9.56	0.105	0.000
2000	7.93	0.076	0.122
2001	7.43	0.091	0.124
2002	5.71	0.129	0.124
2003	8.47	0.184	0.124
2004	9.56	0.103	0.124
2005	7.93	0.077	0.124
2006	7.43	0.088	0.124
2007	5.71	0.129	0.124
2008	8.47	0.183	0.124
2009	9.56	0.103	0.124
2010	9.98	0.166	0.124

TABLE 2. Initial and Final Water Storage Values for All Layers.

Layer	Description of Material	Initial Water Storage at the Beginning of 1991 (Vol./Vol.)	Final Water Storage at the End of 2010 (Vol./Vol.)	Change in Water Storage (Vol./Vol.)
1	Ore Heap	0.0850	0.0795	-0.0055
2	PVC Liner	0.0000	0.0000	0.0000
3	Soil	0.2590	0.2590	0.0000
4	Rhyodacite above GWT	0.0300	0.0357	0.0057
5	Rhyodacite below GWT	0.0870	0.0860	-0.0010
6	Limestone	0.0070	0.0073	0.0003
7	Shale	0.0070	0.0070	0.0000
8	Limestone/Shale/Dolomite	0.0070	0.0070	0.0000

..um Mine HELP Analysis of Existing Heap Pads

Top Slope = 16.0% = 0.160

16.3′ =196"	**Ore Heap**	k=7x 10^{-2} cm/sec. n=0.40 Field Capacity = 0.085 Wilting Point = 0.013 Initial Moisture = 0.085

20 mil=0.020 in. PVC Liner
Slope = 4.39%=0.0439

4′=48"	**Soil** (SP-SM,SP-5C,CL)	k=5x10^{-4} cm/sec n=0.493 Field Capacity= 0.259 Wilting Point = 0.034 Initial Moisture = 0.259
36′=432"	**Rhyodacite** **(above GWT)**	k=3.6 x10^{-7} cm/sec. n=0.087 Field Capacity= 0.030 Wilting Point = 0.010 Initial Moisture = 0.030
224′=2,688"	**Rhyodacite** **(below GWT)**	k=3.6 x10^{-7} cm/sec. n=0.087 Field Capacity= 0.030 Wilting Point = 0.010 Initial Moisture = 0.087
360′=4320"	**Limestone**	k=1 x10^{-8} cm/sec. n=0.027 Field Capacity= 0.015 Wilting Point = 0.007 Initial Moisture = 0.007
100′=1200"	**Shale**	k=1.2 x10^{-7} cm/sec. n=0.03 Field Capacity= 0.02 Wilting Point = 0.007 Initial Moisture = 0.007
280′=3,360"	**Limestone/Shale** **Dolomite**	k=6.5 x10^{-8} cm/sec. n=0.029 Field Capacity= 0.018 Wilting Point = 0.007 Initial Moisture = 0.007